and of the dew-point. The quantity of water evaporated in a unit of time from the muslin surface may be considered as depending essentially upon the wet-bulb temperature, the dew-point, and the wind.

The *relative humidity*, or the ratio between the moisture that is present in the air and the moisture that it would contain if saturated at its observed temperature is given in Table I as deduced from the 8 a. m. and 8 p. m. observations. The general average for a whole day or any other interval would properly be obtained from the data given by an evaporometer, but may also be obtained, approximately, from frequent observations of the relative humidity.

### SNOWFALL.

The *total monthly snowfall* at each station is given in Tables I and II; its geographical distribution is shown on Chart V. This chart also shows the isotherms of minimum 32° and of minimum 40° for the air within the ordinary thermometer shelter. The former isotherm is an approximate limit to possible snow, while the latter is an approximate southern limit to the regions that report frost in exposed localities.

Snowfalls are reported as follows: 1 to 15 inches in northern New England and western Nebraska; 1 to 6 in northern New York and Ohio; 1 to 9 in northern Michigan and Wisconsin; 1 to 13 in the Dakotas. In the Rocky Mountain Region the highest reported snowfalls were: Colorado, 40; Nevada and California, 16; Oregon, 36; Washington, 14.

The *depth of snow on the ground* at the end of the month is usually shown on Chart VI; it is also shown on the weekly charts of the Climate and Crop Service. At the close of April the snow was confined to isolated mountainous regions and is, therefore, not charted.

*In Canada.*—The following items are gathered from the map for April published by Prof. R. F. Stupart:

British Columbia, the first appearance of Pacific Coast summer type of weather was on April 11, as compared with June 13, 1896. In Osoyoos and Okanagan, after March the weather turned suddenly mild and snow disappeared; everything more advanced than usual. Nicola, snow had gone by the 10th and plowing began. Lower mainland, fruit trees promising good crops, owing to unusual warmth and consequent disappearance of the snow. Northwest Territories and Manitoba, Red River Valley, owing to the melting of an unusually large accumulation of snow, much damage has been done by flooding. Calgary, snow has disappeared. Battleford, vegetation is slow, considering the length of time since the snow melted. Quebec, snow all gone on the 22d.

### ICE.

The *thickness of ice* in the rivers and harbors is shown in detail in the bulletins published by the Weather Bureau every Monday during the winter months. No special reports are at hand for April.

*In Canada.*—Prof. R. F. Stupart reports:

At the close of the month, Calgary, the river is low and free from ice. Prince Albert, river opened on the 19th and is very high. Quebec, navigation opened on the 25th. Charlottetown, P. E. I., ice in the harbor began to break up on the 13th. St. John, N. B., navigation opened on the St. John River on the 24th.

### HAIL.

The following are the dates on which hail fell in the respective States:

Alabama, 3, 8, 30. Arizona, 26. Arkansas, 3, 7, 8, 13, 29. California, 1, 19, 20, 26, 27. Colorado, 7, 23, 24, 27, 28, 29, 30. Connecticut, 28. Florida, 9, 15, 19. Georgia, 5, 6, 9, 29, 30. Idaho, 5, 6, 20, 21. Illinois, 8, 16, 18, 22, 23, 24. Indiana, 11, 13, 16, 23. Indian Territory, 1, 3, 8, 9, 13. Iowa, 4, 16, 20 to 24, 28. Kansas, 1, 2, 3, 6, 8, 9, 19, 21 to 24, 27, 28. Kentucky, 8, 11, 16, 19, 26, 30. Louisiana, 2, 3, 5, 6, 9, 28, 29. Massachusetts, 28. Michigan, 4, 13, 23, 25, 26. Minnesota, 9, 21, 27. Mississippi, 1, 3, 29. Missouri, 1, 3, 7 to 10, 12, 13, 19, 20, 22, 23, 28, 29. Montana, 1, 10, 29. Nebraska, 1, 3, 8, 9, 20 to 24, 28. New Jersey, 5. New Mexico, 26. New York, 5, 17, 19, 22, 23. North Carolina, 5, 8. North Dakota, 3, 4, 5, 7, 10, 11. Ohio, 5, 11, 13, 16, 19, 23, 30. Oklahoma, 1, 7, 9, 13, 23, 27. Oregon, 4, 5, 6, 19, 21, 26. Pennsylvania, 5, 6, 16, 19, 26. Rhode Island, 6. South Carolina, 5, 26. South Dakota, 8, 27. Tennessee, 4, 5, 8, 11, 29. Texas, 6, 7, 13, 14, 21. Utah, 1 to 4, 7, 20, 22. Virginia, 16. Washington, 4, 6, 21. Wisconsin, 21, 24. Wyoming, 20.

### SLEET.

The following are the dates on which sleet fell in the respective States:

Colorado, 6, 23. Connecticut, 28. Idaho, 4, 5. Illinois, 1, 7, 9, 12, 16, 20, 23. Indiana, 8, 9, 16. Iowa, 1, 9, 10, 20. Kentucky, 16. Maine, 9. Massachusetts, 27. Michigan, 6, 7, 9, 16, 18, 29, 30. Minnesota, 5, 8, 11. Missouri, 3, 8, 10, 19, 20. Nebraska, 1, 2, 7, 8, 19, 28. Nevada, 1, 6, 19 to 23, 27. New Hampshire, 5, 11, 27. New York, 7, 9, 17, 27. North Carolina, 1, 2, 10. Ohio, 7 to 11, 13, 16, 17, 20, 21. Oregon, 2, 6. Pennsylvania, 26, 27. South Dakota, 5, 12, 27, 28. Tennessee, 9. Utah, 6, 24. Vermont, 9. Wisconsin, 2, 5, 7, 12, 13, 15, 23, 30.

### WIND.

The *prevailing winds* for April, 1897, viz, those that were recorded most frequently, are shown in Table I for the regular Weather Bureau stations.

The *resultant winds*, as deduced from the personal observations made at 8 a. m. and 8 p. m., are given in Table VIII. These latter resultants are also shown graphically on Chart IV, where the small figure attached to each arrow shows the number of hours that this resultant prevailed, on the assumption that each of the morning and evening observations represents one hour's duration of a uniform wind of average velocity. These figures indicate the relative extent to which winds from different directions counterbalanced each other.

### HIGH WINDS.

*Maximum wind velocities* are given in Table I, which also gives the altitudes of the Weather Bureau anemometers above the ground. Maxima of 50 miles or more per hour were reported during this month at regular stations of the Weather Bureau as follows (maximum velocities are averages for five minutes; extreme velocities are gusts of shorter duration, and are not given in this table):

| Stations. | Date. | Velocity. | Direction. | Stations. | Date. | Velocity. | Direction. |
|---|---|---|---|---|---|---|---|
| | | *Miles* | | | | *Miles* | |
| Amarillo, Tex | 7 | 56 | n. | Dodge City, Kans | 28 | 50 | n. |
| Do | 11 | 54 | n. | El Paso, Tex | 2 | 60 | sw. |
| Do | 23 | 60 | se. | Fort Canby, Wash | 21 | 52 | s. |
| Do | 28 | 58 | n. | Lincoln, Nebr | 28 | 50 | n. |
| Buffalo, N. Y | 19 | 54 | w. | New York, N. Y | 26 | 50 | nw. |
| Do | 26 | 54 | w. | Do | 27 | 58 | nw. |
| Carson City, Nev | 6 | 59 | w. | Sioux City, Iowa | 18 | 54 | nw. |
| Chicago, Ill | 18 | 67 | s. | Do | 27 | 52 | s. |
| Do | 23 | 53 | s. | Tatoosh Island, Wash. | 16 | 55 | e. |
| Do | 23 | 50 | s. | Winnemucca, Nev | 6 | 60 | nw. |

### ATMOSPHERIC ELECTRICITY.

Numerical statistics relative to auroras and thunderstorms are given in Table IX, which shows the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month, respectively.

*Thunderstorms.*—The dates on which the number of reports of thunderstorms for the whole country were most numerous were: 5th, 152; 8th, 127; 23d, 159; 24th, 131. Reports were most numerous in: Illinois, 155; Iowa, 114; Louisiana, 105; Missouri, 176.

Thunderstorm days were most numerous in: Florida, Kan-

sas, and Louisiana, 19 days; Iowa, 17; Nebraska and Texas, 18; Illinois, 20; Missouri, 23.

*Auroras.*—The evenings on which bright moonlight must have interfered with observations of faint auroras are assumed to be the four preceding and following the date of full moon, viz, from the 12th to the 20th, inclusive. On the remaining twenty-one days of this month 228 reports were received, or an average of about 11 per day. The dates on which the number of reports of auroras for the whole country especially exceeded this average were: 1st, 86; 5th, 19; 23d, 30.

Reports were most numerous in. Michigan, 27; Minnesota, 23; New Hampshire and Ohio, 18; New York, 26; North Dakota, 35.

The number of reports was a large percentage of the number of observers in: North Dakota, 90; New Hampshire, 78; Minnesota, 33; Michigan and New York, 28.

### CANADIAN REPORTS.

Thunderstorms were reported as follows: Father Point, 23d; Quebec, 23d; Montreal, 23d, 25th; Rockliffe, Toronto, Kingston, Port Stanley, 23d; Saugeen, 4th; Parry Sound, 24th; Port Arthur, 22d; Winnipeg, 18th, 24th.

Auroras were reported as follows: Halifax, 16th; Grand Manan, 24th; Yarmouth, 1st; St. Andrews, 20th; Father Point, 1st, 27th; Quebec, 1st, 3d, 23d; Montreal, 1st; Toronto, 1st; White River, 1st, 4th, 5th; Port Stanley, 1st: Saugeen, 1st; Port Arthur, 6th, 14th, 24th; Winnipeg, 1st, 2d, 4th, 7th, 20th, 23d, 24th; Minnedosa, 1st, 7th, 9th, 12th, 16th, 19th, 24th, 25th, 26th, 29th; Qu'Appelle, 16th; Medicine Hat, 23d, 24th, 27th; Calgary, 9th; Prince Albert, 2d, 16th, 24th, 30th; Battleford, 7th; Banff, 20th, 21st; Sable Island, 1st.

## SUNSHINE AND CLOUDINESS.

The quantity of sunshine, and therefore of heat, received by the atmosphere as a whole is very nearly constant from year to year, but the proportion received by the surface of the earth depends upon the absorption by the atmosphere, and varies largely with the distribution of cloudiness. The sunshine is now recorded automatically at 22 regular stations of the Weather Bureau by its photographic, and at 37 by its thermal effects; at one of these stations records are kept by both methods. The photographic record sheets show the apparent solar time, but the thermometric record sheets show seventy-fifth meridian time; for convenience the results are all given in Table X for each hour of local mean time. In order to complete the record of the duration of cloudiness these registers are supplemented by special personal observations of the state of the sky near the sun in the hours after sunrise and before sunset, and the cloudiness for these hours has been added as a correction to the instrumental records, whence there results a complete record of the duration of sunshine from sunrise to sunset.

The average cloudiness of the whole sky is determined by numerous personal observations at all stations during the daytime, and is given in the column "average cloudiness" in Table I; its complement, or percentage of clear sky, is given in the last column of Table X.

### COMPARISON OF DURATIONS AND AREAS.

The sunshine registers give the *durations* of effective sunshine whence the durations relative to possible sunshine are derived; the observers' personal estimates give the percentage of *area* of clear sky. These numbers have no necessary relation to each other, since stationary banks of clouds may obscure the sun without covering the sky, but when all clouds have a steady motion past the sun and are uniformly scattered over the sky, the percentages of duration and of area agree closely. For the sake of comparison, these percentages have been brought together, side by side, in the following table, from which it appears that, in general, the instrumental records of percentages of durations of sunshine are almost always larger than the observers' personal estimates of percentages of area of clear sky; the average excess for April, 1897, is 9 per cent for photographic and 8 per cent for thermometric records.

The details are shown in the accompanying table, in which the stations are arranged according to the *total possible* duration of sunshine, and not according to the *observed* duration.

*Difference between instrumental and personal observations of sunshine.*

| Stations. | Latitude. | | Apparatus. | Total possible duration for the whole month. | Personal estimated area of clear sky. | Instrumental record of sunshine. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Photographic. | Difference. | Thermometric. | Difference. |
| | ° | ′ | | *H'rs.* | % | % | % | % | % |
| Tampa, Fla | 27 | 57 | T. | 385.4 | 50 | ..... | ..... | 54 | + 4 |
| Galveston, Tex | 29 | 18 | P. | 386.4 | 64 | 72 | + 8 | ..... | ..... |
| New Orleans, La | 29 | 58 | T. | 387.4 | 33 | ..... | ..... | 33 | 0 |
| Savannah, Ga | 32 | 05 | P. | 389.9 | 53 | 61 | + 8 | ..... | ..... |
| Vicksburg, Miss | 32 | 22 | T. | 389.9 | 75 | ..... | ..... | 78 | + 3 |
| San Diego, Cal | 32 | 43 | P. | 390.5 | 75 | 76 | + 1 | ..... | ..... |
| Charleston, S. C. | 32 | 47 | T. | 390.5 | 61 | ..... | ..... | 70 | + 9 |
| Phœnix, Ariz | 33 | 28 | P. | 390.5 | 89 | 95 | + 6 | ..... | ..... |
| Atlanta, Ga | 33 | 45 | T. | 391.6 | 54 | ..... | ..... | 59 | + 5 |
| Los Angeles, Cal | 34 | 03 | P. | 391.6 | 69 | 80 | +11 | ..... | ..... |
| Wilmington, N. C. | 34 | 14 | T. | 391.6 | 62 | .... | ..... | 69 | + 7 |
| Little Rock, Ark | 34 | 45 | T. | 392.7 | 47 | ..... | ..... | 68 | +21 |
| Chattanooga, Tenn | 35 | 04 | T. | 392.7 | 47 | ..... | ..... | 54 | + 7 |
| Santa Fe, N. Mex | 35 | 41 | P. | 393.6 | 62 | 73 | +11 | ..... | ..... |
| Raleigh, N. C. | 35 | 45 | T. | 393.6 | 57 | ..... | ..... | 76 | +19 |
| Nashville, Tenn | 36 | 10 | T. | 393.6 | 54 | ..... | ..... | 60 | + 6 |
| Fresno, Cal | 36 | 43 | T. | 394.8 | 88 | ..... | ..... | 93 | + 5 |
| Dodge City, Kans | 37 | 45 | P. | 396.2 | 57 | 66 | + 9 | ..... | ..... |
| San Francisco, Cal | 37 | 48 | T. | 396.2 | 70 | ..... | ..... | 81 | +11 |
| Louisville, Ky | 38 | 15 | T. | 396.2 | 40 | ..... | ..... | 55 | +15 |
| St. Louis, Mo | 38 | 38 | T. | 397.0 | 38 | ..... | ..... | 52 | +14 |
| Washington, D. C | 38 | 54 | P. | 397.0 | 60 | 67 | + 7 | ..... | ..... |
| Kansas City, Mo | 39 | 05 | P. | 397.0 | 40 | 48 | + 8 | ..... | ..... |
| Cincinnati, Ohio | 39 | 06 | T. | 397.0 | 44 | ..... | ..... | 49 | + 5 |
| Baltimore, Md | 39 | 18 | T. | 397.0 | 55 | ..... | ..... | 54 | − 1 |
| Atlantic City, N. J | 39 | 22 | P. | 397.0 | 57 | 70 | +13 | ..... | ..... |
| Denver, Colo | 39 | 45 | P. | 398.6 | 51 | 69 | +18 | ..... | ..... |
| Indianapolis, Ind | 39 | 46 | T. | 398.6 | 39 | ..... | ..... | 50 | +11 |
| Philadelphia, Pa | 39 | 57 | T. | 398.6 | 51 | ... | ..... | 72 | +21 |
| Columbus, Ohio * | 39 | 58 | T. | ..... | 30 | ..... | ..... | ..... | ..... |
| Pittsburg, Pa | 40 | 32 | T. | 399.4 | 38 | ..... | ..... | 43 | + 5 |
| New York, N. Y | 40 | 43 | T. | 399.4 | 58 | ..... | ..... | 76 | +18 |
| Salt Lake City, Utah | 40 | 46 | P. | 399.4 | 50 | 67 | +17 | ..... | ..... |
| Eureka, Cal | 40 | 48 | P. | 399.4 | 51 | 60 | + 9 | ..... | ..... |
| Cheyenne, Wyo | 41 | 08 | P. | 399.4 | 52 | 60 | + 8 | ..... | ..... |
| Omaha, Nebr | 41 | 16 | P. | 399.4 | 41 | 50 | + 9 | ..... | ..... |
| Cleveland, Ohio | 41 | 30 | T. | 401.1 | 26 | ..... | ..... | 32 | + 6 |
| Des Moines, Iowa | 41 | 35 | T. | 401.1 | 44 | ..... | ..... | 47 | + 3 |
| Chicago, Ill | 41 | 53 | T. | 401.1 | 46 | ..... | ..... | 49 | + 3 |
| Erie, Pa | 42 | 07 | T. | 401.1 | 40 | ..... | ..... | 46 | + 6 |
| Binghamton, N. Y | 42 | 06 | T. | 401.1 | 42 | ..... | ..... | 48 | + 6 |
| Detroit, Mich | 42 | 20 | T. | 401.1 | 33 | ..... | ..... | 41 | + 8 |
| Boston, Mass | 42 | 21 | T. | 401.1 | 50 | ... | ... | 57 | + 7 |
| Dubuque, Iowa | 42 | 30 | T. | 401.1 | 49 | ..... | ... | 44 | − 5 |
| Albany, N. Y | 42 | 39 | T. | ..... | 38 | ..... | ..... | ..... | ..... |
| Buffalo, N. Y. † | 42 | 53 | T. | 346.1 | 30 | .... | ..... | 50 | +29 |
| Rochester, N. Y | 43 | 08 | T. | 402.1 | 44 | ..... | ..... | 47 | + 3 |
| Idaho Falls, Idaho | 43 | 29 | T. | 402.1 | 72 | ..... | ..... | 64 | − 8 |
| Portland, Me | 43 | 39 | T. | 403.6 | 49 | ..... | ..... | 63 | +14 |
| Northfield, Vt | 44 | 10 | P. | 403.6 | 35 | 46 | +11 | ..... | ..... |
| Eastport, Me | 44 | 54 | P. | 405.2 | 37 | 45 | + 8 | ..... | ..... |
| St. Paul, Minn | 44 | 58 | P. | 405.2 | 46 | 53 | + 7 | ..... | ..... |
| Minneapolis, Minn | 44 | 59 | T. | 405.2 | ..... | ..... | ..... | 38 | ..... |
| Portland, Oreg | 45 | 32 | T. | 407.0 | 60 | ..... | ..... | 61 | + 1 |
| | 45 | 32 | P. | 407.0 | 60 | 65 | + 5 | ..... | ..... |
| Helena, Mont | 46 | 34 | P. | 408.4 | 54 | 58 | + 4 | ..... | ..... |
| Bismarck, N. Dak | 46 | 47 | P. | 408.4 | 41 | 45 | + 4 | ..... | ..... |
| Seattle, Wash | 47 | 38 | T. | 410.4 | 57 | ..... | ..... | 57 | 0 |
| Spokane, Wash. * | 47 | 40 | P. | ..... | 43 | ..... | ..... | ..... | ..... |

* Instrument out of order.

† 26 days only; the total possible for 30 days is 402.1; personal estimate, 33 per cent.